DETERMINATION OF THE CLEARANCE CHART WITH CLOSE-RANGE PHOTOGRAMMETRY

Pof. Dr. Sc. Á Detrekői, dr. K. Fekete , A. Knyihr

Technical University of Budapest, Dept. of Photogrammetry, Hungary, ISPRS commission V.

ABSTRACT:

The Hungarian Railway in 1986 entrusted the Chair of Photogrammetry of the Technical University of Budapest with the working up of a clearance chart testing system based on photogrammetrical system. The paper describes the main characteristics of this system: the photography by reseau-cameras,the calibration of the system, the stereoplotting using rebuilded, stereo-comparator, the program system of the calculation The system started to work in 1991 on experimental mode. The first results are suitable, the system insures the required precision.

KEY WORDS: Close-Range, Analytical, Non-metric.

1. INTRODUCTION

In the year of 1986 the Hungarian Railways (MAV) entrusted the department of Photogrammetry of the Technical University of Budapest with the working up of a clearance chart testing system based on photogrammetrical principle.

On the various railways there are a lot of consignments which are much larger than usual ones. They are even larger than the theoretical clearance charts.

For the planning of an undisturbed route for these consignments we have to know the real dimensions of the cealrance charts. The procedure of measurement is usually very slow when using the conventional methods and is not to be credited. This fact demands for the elaboration of new photogrammetrical systems.

The two main parameters of the evolving systems were: 1., making serial exposures in rapid succession at a rate of 60km/h; 2., the precision of the points to determine were characterized by a standard deviation of 10mm.

2. THE APPLIED METHOD

We could hardly ever find in the professional literature data concerning photogrammetrical measurements. The Swedish system (Magnussen at al., 1975) is of two pictures, the Danish one (Aaberg, 1978) is based on a one-picture shot principle. The Austrian system (Presle et al., 1987) evolved at the same time with ours is stereophotogrammetrical too.

For the selection of the applied method we tested a lot of various metric or nonmetric cameras, photo systems, methods of taking photographs and processing methods. The photo systems were to some extent photographic instruments (phototeodolites, reseau-cameras, simple amateur cameras), partly CCD-sensors and inpart video cameras.

We compared the one-pictured arrangements to the two pictured ones. We examined the analog and analytical photogrammetrical measurements and also tested the adaptability of digital image processing. Taking into consideration three things: 1., the precission requirements; 2., the sum at the disposal of us and 3., the expectable conditions of the working we suggested the elaboration of a stereophotogrammetrical system based on reseau-cameras. We also proposed the extension of a special analytic system for the measurements and as a mahtematical method the bundle adjustment. We made the system suitable for the graphic representation of the results and also the junction to a special railway information system. The presentation of the measuring system is separated into its components or its stages of work.

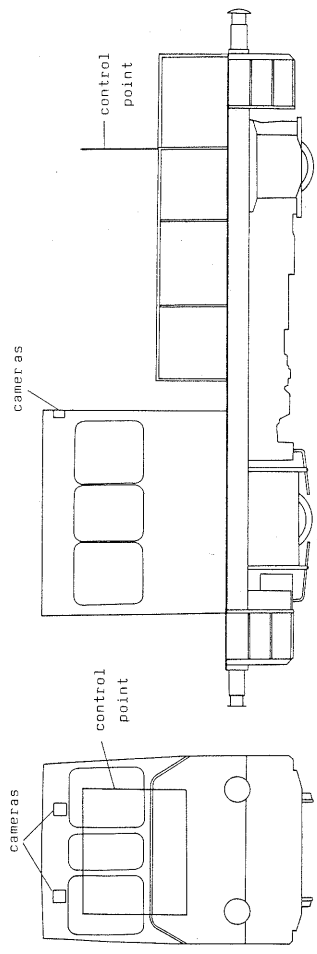
3. PHOTOGRAPHY

In order to make the photos there was modificated a rail car, figure 1. This specially rebuilt motor engine consists of two parts a compartment and a platform. In the compartment there are two cameras and the flashes which serve for the light. The auxiliary machines are there too; they insure complementary information.

Figure 1. Rail Car

a) Front view

b) Lateral view



The two cameras are equipped with Rolleimatric with reseau, they make the photos. The pictures are made usually on very sensible films. The location of the cameras was determined partly by direct measurement, partly by calibration; we shall write about the calibration later. In order to insure the required illumination from time to time - we used two flashes of great efficiency. The system of controlpoints was made by invar bars they were situated on the platform. It served as the repeated determination of the elements of orientation marks/ checkpoints.

We started our first experiments in autumn 1990 they proved that the elaborated system is suitable - under regulated speed conditions - for making good quality snapshots.

4. CALIBRATION OF MEASURING SYSTEM

The calibration of the measuring system means the location of the points of minor control and also the location of the distinctive points. Calibration was made on an expecially located area of the Hungarian Railways. The necessary measurements were made by second theodolite and by invar tapes.

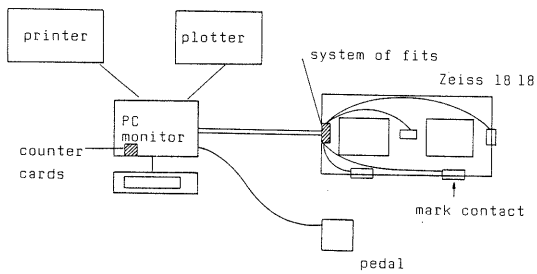
The precision of the cariblation up to present is characterized by the standard deviation of 0.5mm of the coordinates. The comparison (cross-cheking of the results of calibration made in different times indicates the considerable stability of the points of minor control.

5. THE STEREOPLOTTING

We made some previous analysis concerning the stereoplotting and it seemed clear that we needed a working evaluation system based on analytical principle. The use of an analytical plotter - this accomplishment seemed evident - we could not afford. In its lack we suggested the required transformation of a rather old stereo-comparator type Zeiss 1818.

After its service, adjustment and (re)calibration this instrument was fit with / equipped with an electronic marker and an impulse-transforming circuit. This made possible the mensurration of the rotation of the four measuring springs with electronic marks. These marks generate an independent succession of square-waves. This succession was fitted with the counter cards of an IBM XT compatible personel computer throw a shield of buched cable.

The couter cards are suitable for the registration of the incoming marks under the influence of the software and partly under the influence of the pedal. The measuring system was completed even with a printer and a plotter. The principle of the struture of the measuring system is depicted in the figure 2:



The elaborated measuring system is suitable for the location of every single image-point of the co-ordinates of the instrument to the precision of 0.005mm. In order to process the pairs of points by means of this measuring system, the following types of points can be measured:

- reseau points
- prints of minor control
- points of the rail serving the location of the clearance chart
- points of the clearance chart.

6. THE PROGRAM SYSTEM

The evaluation program system is controlled by personal computer. The system contains five pseudo-systems:

- universal
- measuring
- calculation
- drawing
- data transmitter.

The measuring pseudo-system insures the identification, the storage and the processing of the measured coordinates. The principal task of the pseudo-system is to describe grphically the situation of the counter card throw the built-in driving gear of the software and the storage of the measured points with their scores and coordinates. The processing og the measured data contains the following operations:

- error filtering (based on repeated measuring)
- centralization
- conversion to the calibration coordinate system
- correction of the bad drawing.

The task of the measuring pseudo-system is the determination of the points of the clearance chart. The two teps of the calculation are:

- determination of the points of minor control
- transformation of the points of the clearance chart into the chart.

The first step is equalization of the bundle of rays. The programme of the equalization of the bundle of rays was built in the usual way, departing from the collinear equation.

The calculation was devided into two parts: the simulaneous resection at the place of perspective center wards the intersection of the point of the clearance chart. The task can be solved by the point situated on the platform of the rail car. Then are the points of minor control.

The second step is the transformation of the points into the clearance chart. This was made by putting the chosen measured points of the rail to its proper use, the transformation was based on spatial similitude. The task of the drawing pseudo-system is the generalization of the evaluted clearance charts drawn by the plotter. The plotter drawing is an obstacle drawing. This drawing contains the datum lines of the clearance chart. The sample of the clearance chart which is valid at a given portion and the edge of the abstacle. (The plotter draws the points in such order in which the evaluation was made. Afterwards it draws the obstacle.)

The data transmitter pseudo-system insures the transmission of the gained values into a railway information system, which will be established in the future. This system makes suitable the determination of the optimal route of the larger consignments.

7. EXPERIENCES

The system started work in 1991 in an experiental mode. So far 100km of railroad photographs were made. The processing of the results is made gradually. the greatest standard deviation was of 0.012mm. The standard deviation of the coordinates of the transverse profile of the intersected points was of 4mm.

8. CONCLUSIONS

A stereo Photogrammetrical system for the determination of the clearance chart. The system inclde reatively cheep elements (nonmetric cameras, rebuilded Zeiss 1818 Stereocomparator). The system incurs the required precision too.

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